Managing Grid Resources

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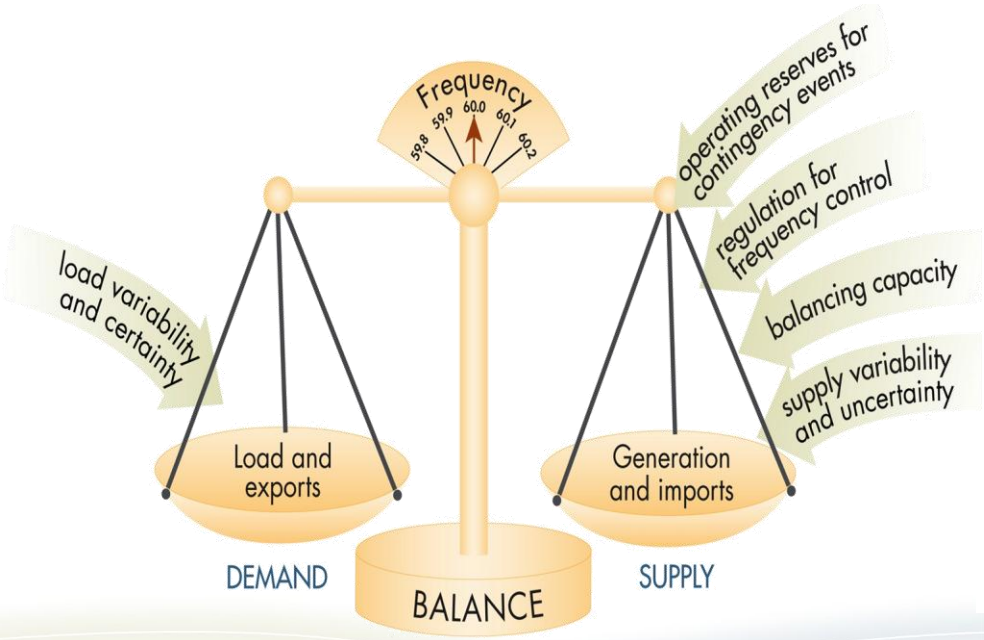
38 Balancing Authority Areas responsible for balancing real-time supply/demand and hourly interchange

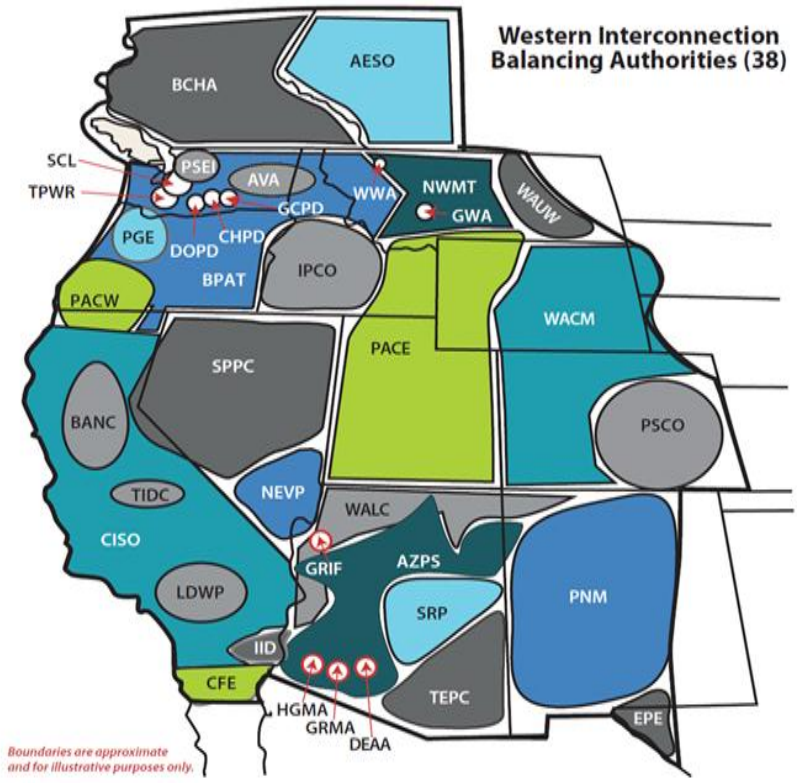
Electricity is produced, delivered, and consumed at the speed of light

The ISO balances the system in two timeframes:

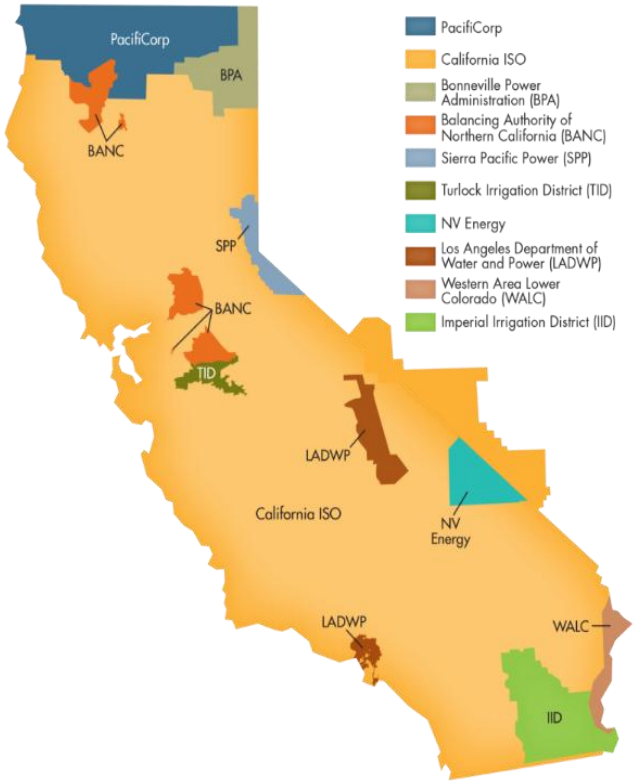
- Market down to 5-minute resolution
- AGC on a 4-second basis

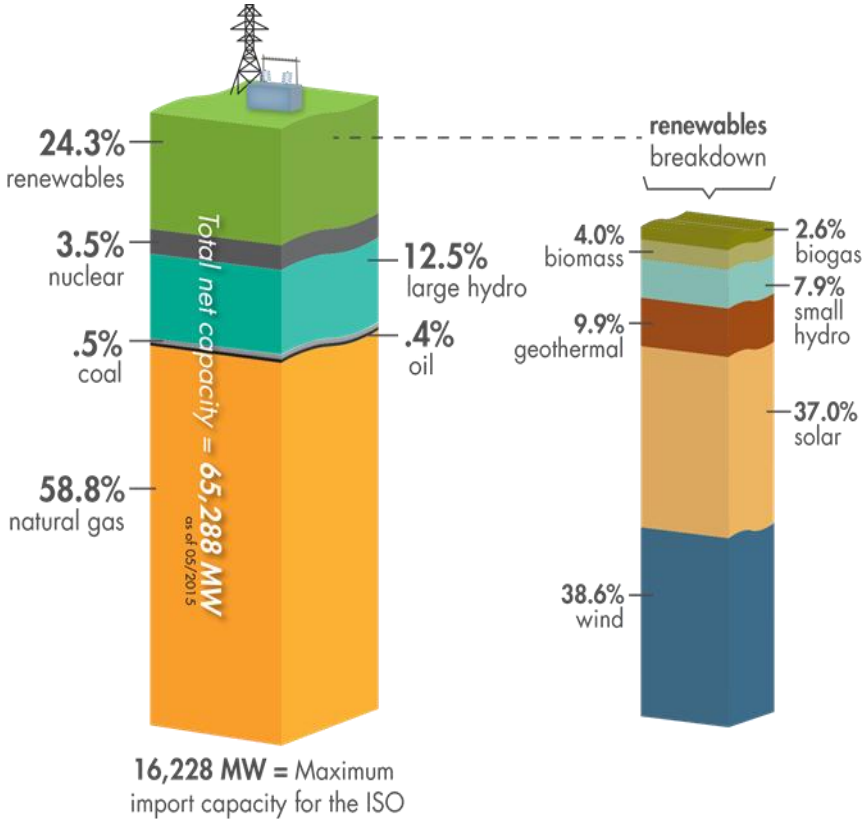


WECC is the regional entity for the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 Western states between



California ISO





- **60,703** MW of power plant capacity
- **50,270** MW record peak demand (July 24, 2006)
- **30 million** people served
- **26,024** circuit-miles of transmission lines
- **246 million** megawatt-hours of electricity delivered annually

CAISO markets match supply & demand for reliability in day-ahead through real-time

Day Ahead Market

Hourly market for 24 hours of next day

Establish energy and ancillary service schedules

Manage congestion (transmission access) using Full Network Model (FNM)

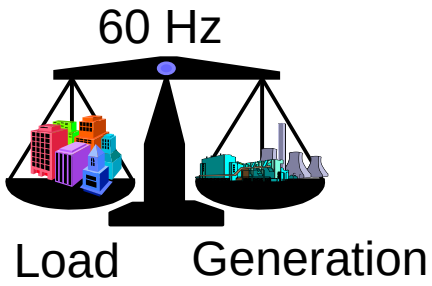
Determine residual unit commitment requirements

Hourly & 15-minute Scheduling

Prior to real-time (RT) market, schedule energy and ancillary services for static interchange for 24 individual hours

Manage congestion using FNM

As one of 4 RT pre-dispatch processes, establish unit commitment & advisory schedules for internal & dynamic resources



Real Time Market

Manage energy flows on transmission grid with telemetry and 1-minute state estimator solutions

Update FNM for RT conditions

Dispatch balancing energy/ ancillary service

Power industry transformation

Wind

- Unpredictable Output
- 4769 MW Peak – April 12, 2014
- 6717 MW Total Capacity

Solar Thermal / Photo Voltaic

- Semi – Predictable Output
- 6506 MW Peak – September 17, 2015
- 8374 MW Installed Capacity

Roof Top Solar

- Semi – Predictable Output
- Behind the meter – Residential
- 3130 MW Estimated Capacity

Main Drivers:

- ✓ California RPS
- ✓ GHG reduction
- ✓ Once-through-cooled plants retirement
- ✓ Challenging operating conditions

Goals:

- ✓ Higher expectation of reliability
- ✓ Higher expectation of security
- ✓ Smart Grid
- ✓ Situational awareness through Visualization

Comparing conventional to variable generation

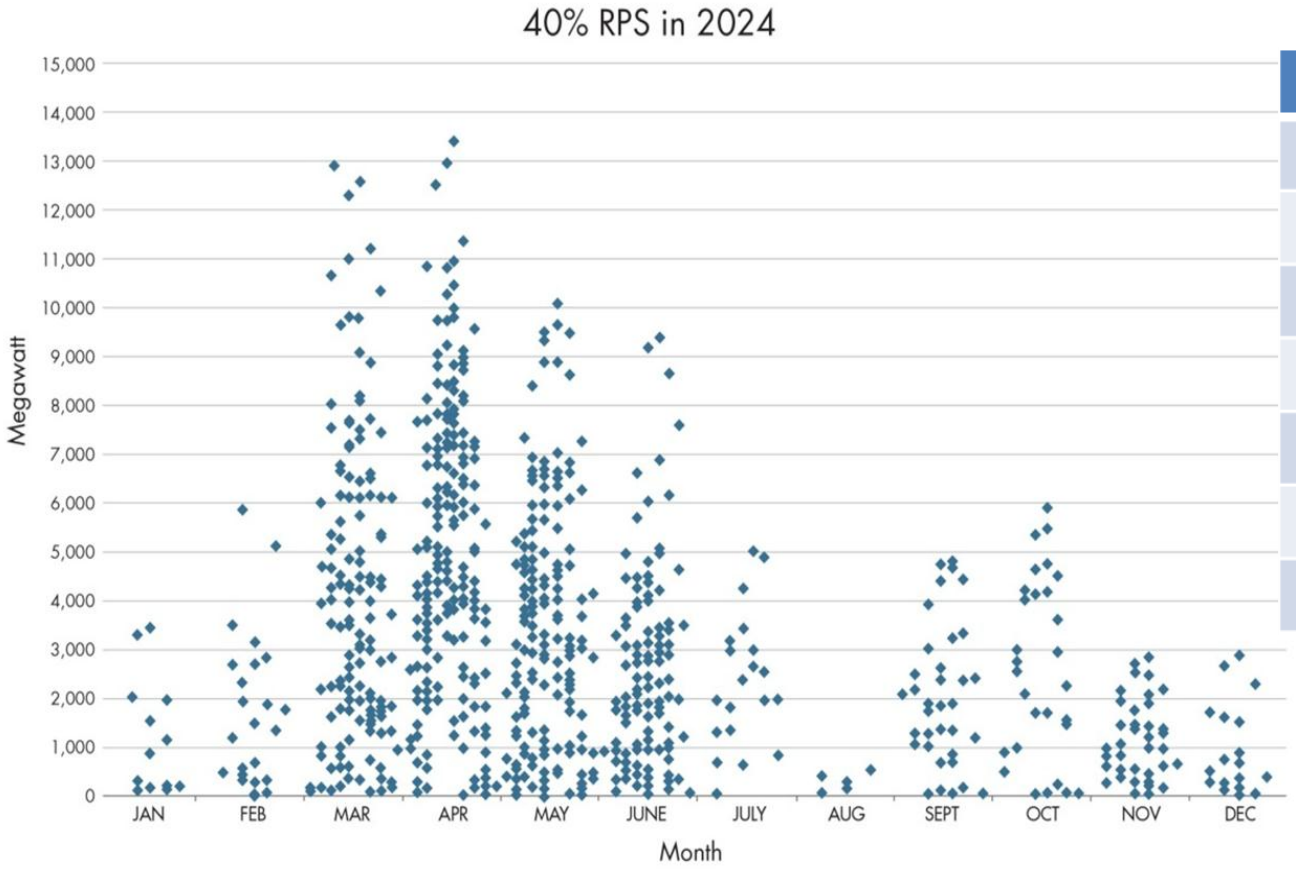
Conventional Generation

- Predictability
- No surprises
- Dependable energy schedules
- Accurate forecasts
- Contingency reserves available
- Generators that follow dispatch commands
- Excellent tools for visibility of system status
- High quality data
- De-rate information on units is timely and accurate

Variable Generation

- Hard to predict
- Forecast inaccuracy is high
- Maximum generation at night when loads are low and there is no place for the energy – 70 % of the wind produced during a 24 hour period is at nights and 30 % of the Solar produced in a week is on weekends
- Large ramp demands both up and down
- Lack of visibility of anticipated generation production changes
- May not follow dispatch commands --- treated as “Must Take” generation

Renewable Curtailment in 2024 at 40% RPS



Solutions
Targeted Energy Efficiency
Retrofit existing power plants
Enable economic dispatch of renewables
Decarbonize transportation fuels
Increase storage and demand response
Align time-of-use rates with system conditions
Deeper Regional Coordination & EIM

Summary of operational changes to balancing supply and demand

1. **Downward ramping capability**

   Thermal resources operating to serve loads at night must be ramped downward and potentially shut down to make room for a significant influx of solar energy after the sun rises.

2. **Minimum generation flexibility**

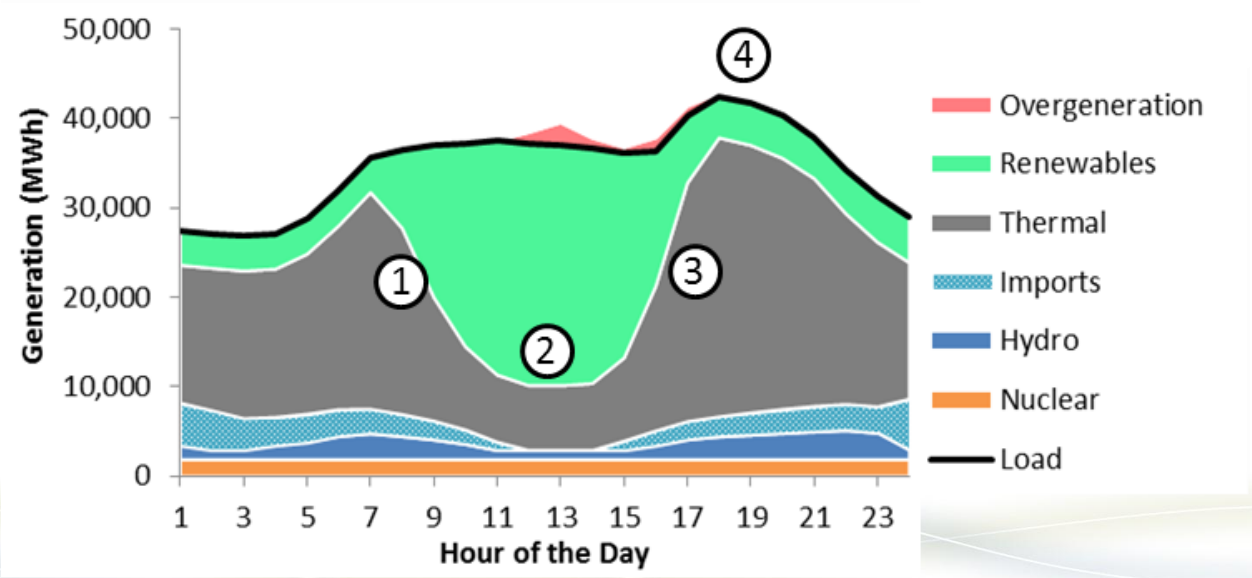
   Overgeneration may occur during hours with high renewable production even if thermal resources and imports are reduced to their minimum levels. A system with more flexibility to reduce thermal generation will incur less overgeneration.

3. **Upward ramping capability**

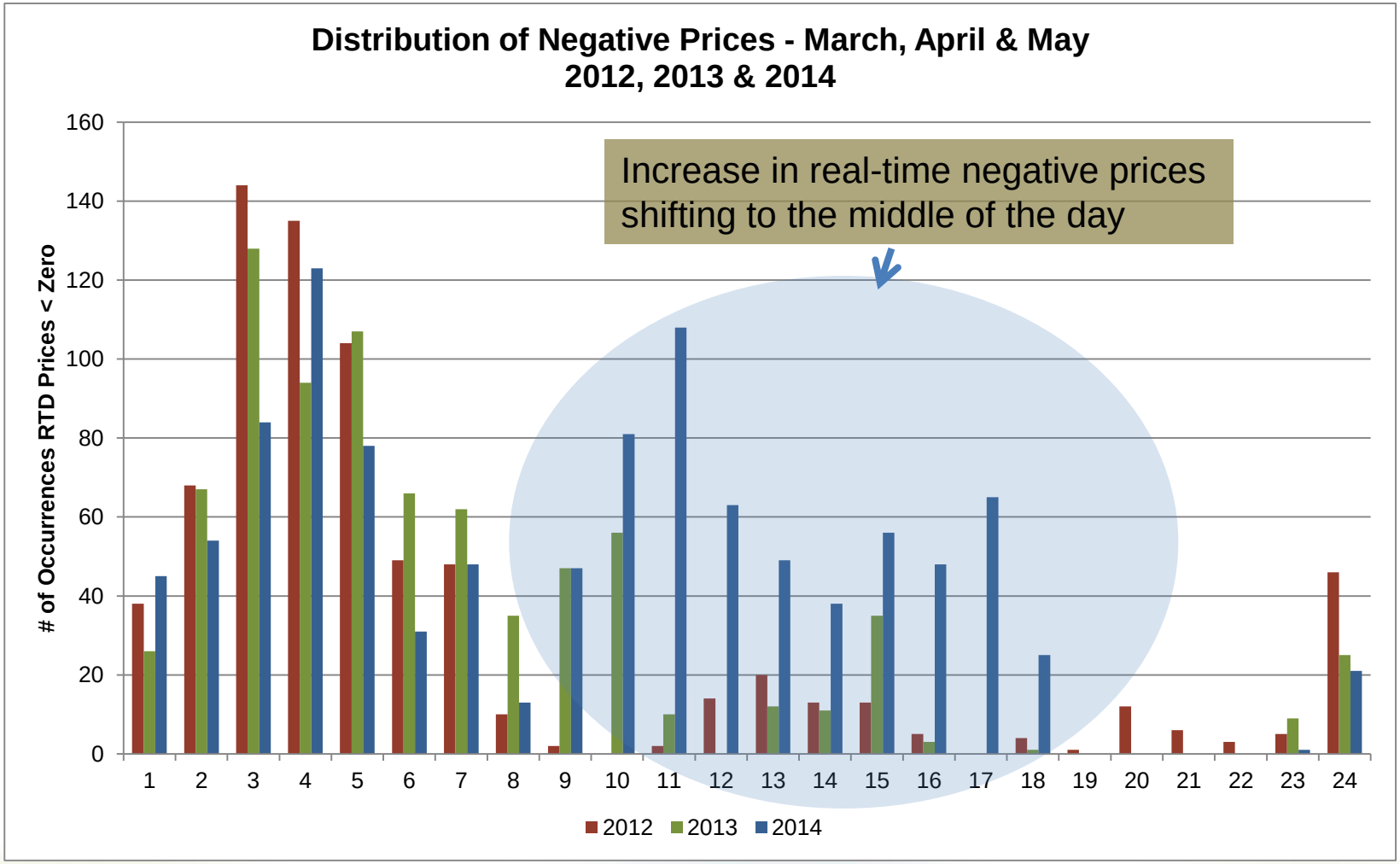
   Thermal resources must ramp quickly from minimum levels during daytime hours and new units may be required to start to meet high net peak demand occurring shortly after sundown.

4. **Peaking capability**

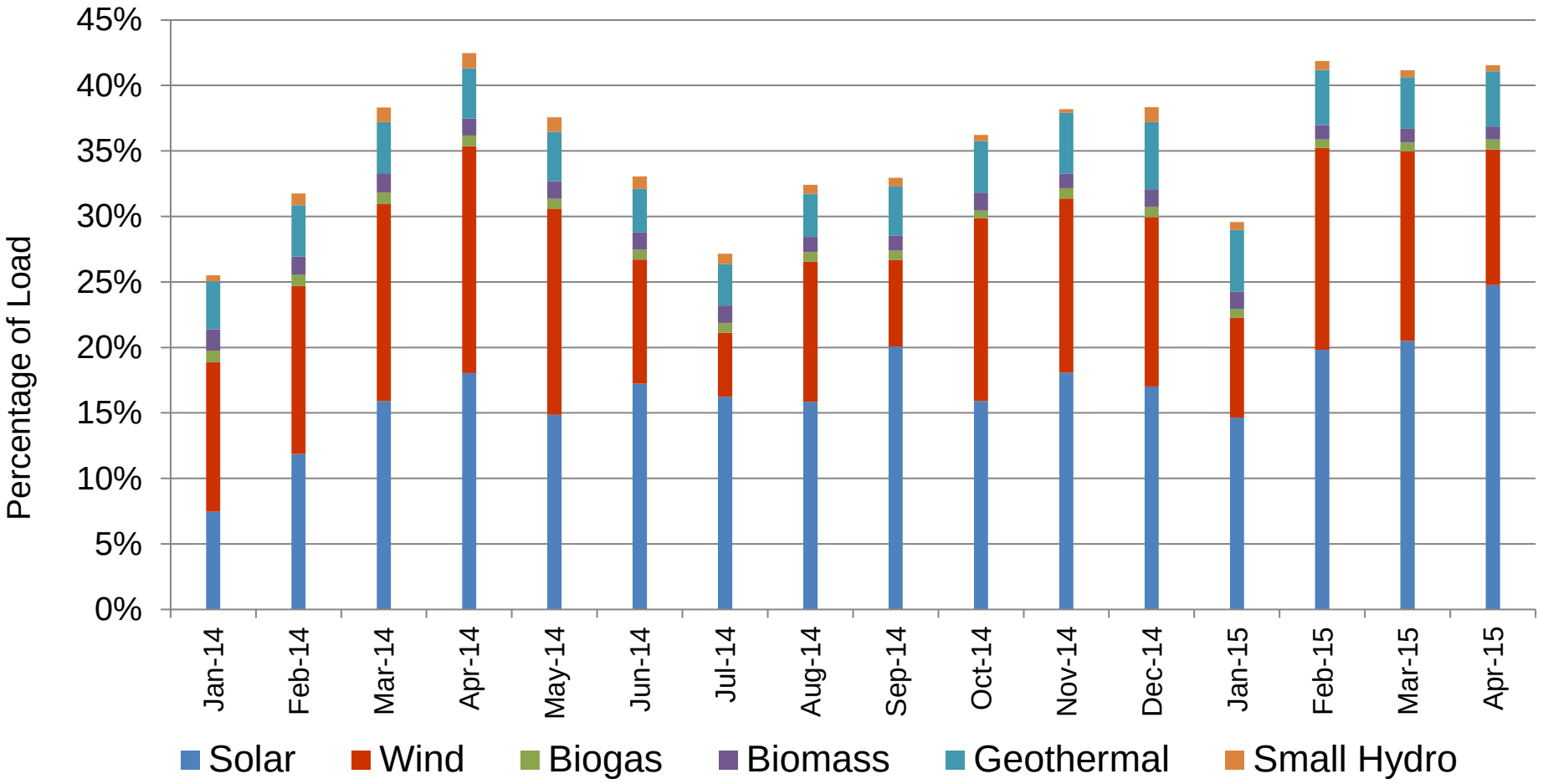
   The system will need enough resources to meet the highest net-loads with sufficient reliability



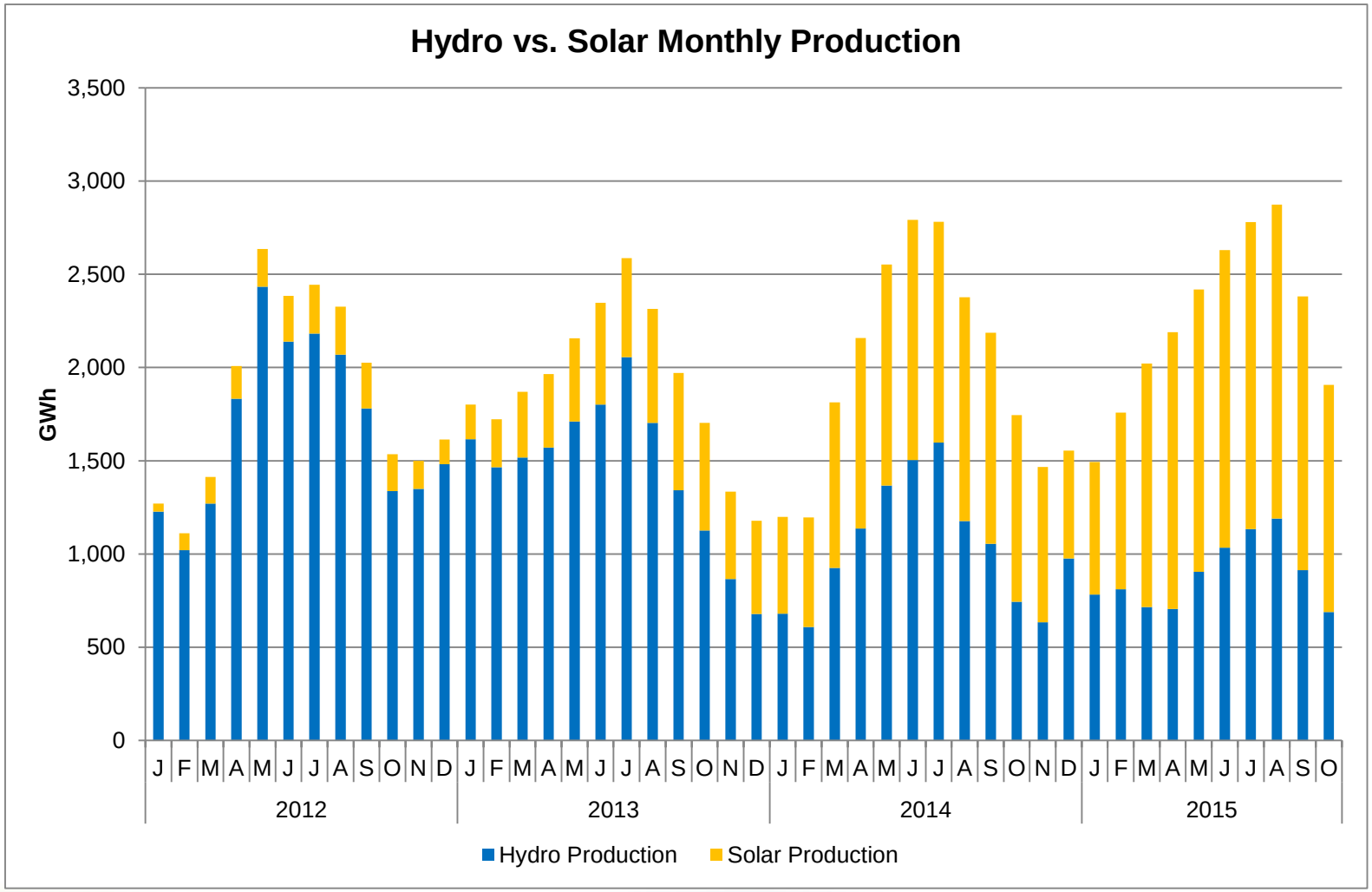
Negative energy prices indicating over-generation risk start to appear in the middle of the day.



At times 40% hourly demand met by renewables

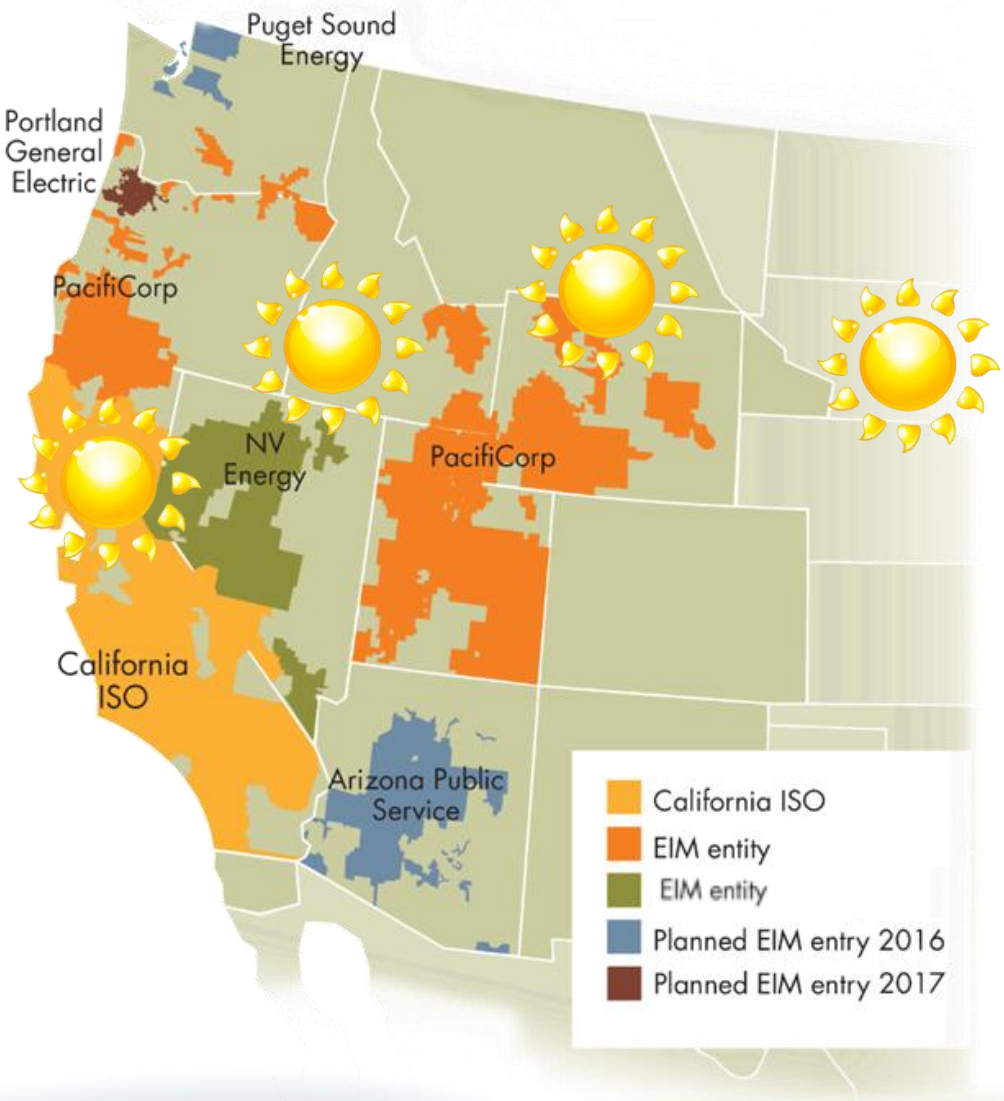


Hydro vs. solar monthly production --- 2012 through October 2015



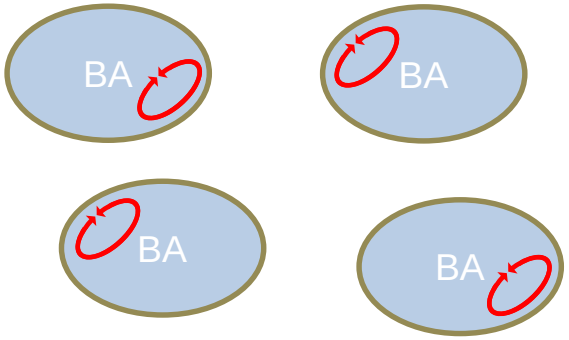
Energy Imbalance Market is an important tool for effective use of resources around the west

- Builds on existing market
- Automated dispatch resolves imbalance & avoids congestion
- Provides situational awareness, enhances reliability
- Voluntary and no exit fees
- Preserves autonomy, including compliance, balancing, and reserve obligations



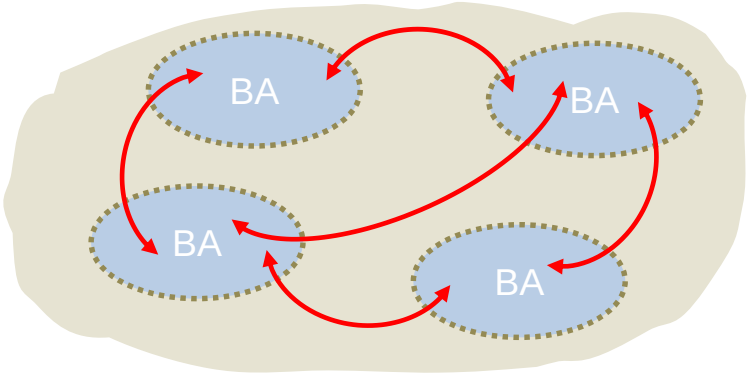
Energy Imbalance Market increases efficiency

Prior to EIM:
Each BA must balance loads and resources w/in its borders.



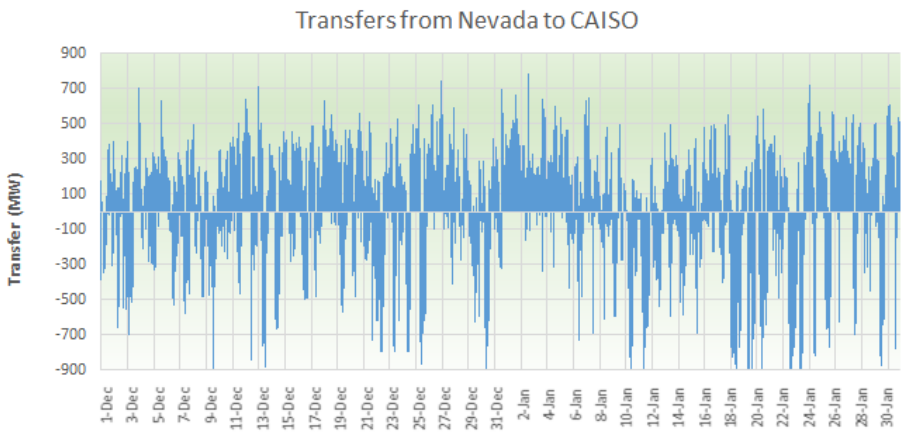
- Limited pool of balancing resources
- Inflexibility
- High levels of reserves
- Economic inefficiencies
- Increased costs to integrate wind/solar

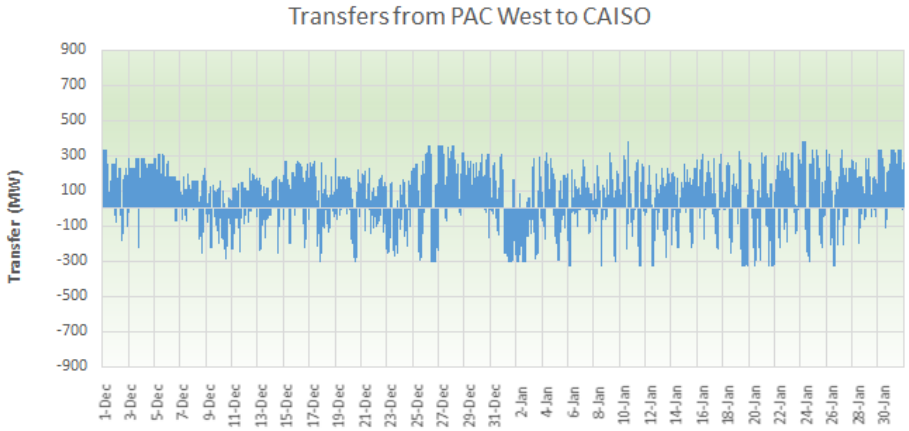
In an EIM:
The market dispatches resources across BAs to balance energy

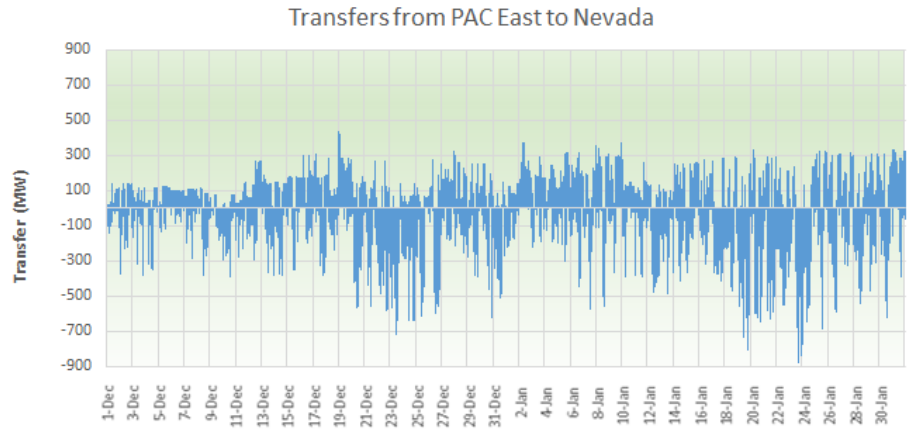


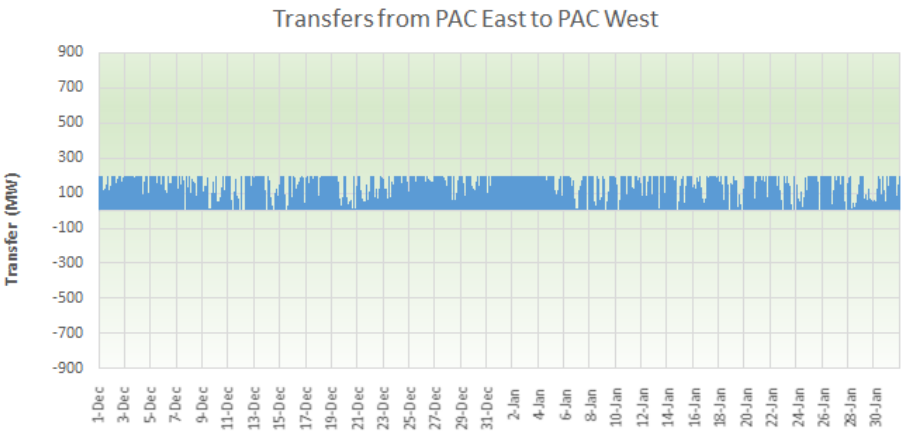
- Diversity of balancing resources
- Increased flexibility
- Decreased flexible reserves
- More economically efficient
- Decreased integration costs

Market-driven energy transfers among balancing authority areas









SB 350: Clean Energy and Pollution Reduction Act of 2015

- By 2030, double energy efficiency for electricity and natural gas by retail customers
- 50% Renewable Portfolio Standard (RPS) by 2030
- Process for the ISO to transform into a regional organization